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Childhood Oral Health and SES Predictors of Caries in 30-Year-Olds

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Key Words
Caries · Life course · Young adults

Abstract
Background/Aims: To assess whether childhood socio-economic status modifies the relationship between childhood caries and young adult oral health. ***Methods:*** In 1988–1989, a total of 7,673 South Australian children aged 13 years were sampled, with 4,604 children (60.0%) and 4,476 parents (58.3%) responding. In 2005–2006, 632 baseline study participants responded (43.0% of those traced and living in Adelaide). ***Results:*** Adjusted analyses showed significant interactions for card status by DMFT at age 13 for decayed, missing and filled teeth at age 30, but not for DMFT. Higher DMFT at age 13 was associated with more decayed teeth at age 30 for those with no health card, while there were similar numbers of decayed teeth for card holders regardless of their DMFT at age 13. While higher DMFT at age 13 was associated with more missing teeth at age 30 for card holders, there were similar numbers of missing teeth for those with no card regardless of their DMFT at age 13. The interaction for filled teeth showed that even though higher DMFT at age 13 was associated with more fillings at age 30 for both card holders and those with no card, this relationship was more pronounced for card holders. ***Conclusions:*** SES modified the relationship between child oral health and caries at age 30 years. Card holders at age 13 were worse off in terms of their oral health at age 30 controlling for childhood oral health, supporting social causation explanations for oral health inequalities.

Social gradients in oral health have been widely documented. Such findings span many countries and include measures such as caries experience [Geyer et al., 2010; Brennan et al., 2011], periodontal disease [Borrell and Crawford, 2008], edentulism [Tsakos et al., 2011], and perceived oral health [Sabbah et al., 2007]. Caries risk has also been related to previous caries experience [Disney et al., 1992], with caries in the primary dentition predictive of caries in permanent teeth [Li and Wang, 2002], and caries at age 12 being predictive of caries at age 18 years [David et al., 2006].

Caries may therefore be related to a range of factors, including previous caries and socio-economic status (SES). While it is plausible that previous caries may reflect a relationship of biological risk resulting in further caries at a later age, it is also possible that the biological risk-caries development relationship may be modified by SES. For example, does high SES have a protective effect when risk (i.e. previous caries) is higher? Also, does low SES exacerbate ill health when risk (i.e. previous caries) is higher?

Social determinants of health have been explored using theoretical approaches such as life course analysis [Watt, 2002]. Life course explanations for oral health inequalities examine interrelations of materialist, behavioural and psychosocial factors over time [Sisson, 2007]. The life course framework looks at how determinants of health across the life course may affect disease risk [Nicolau et al., 2007]. In this paper oral health is examined across the life stage from early adolescence to young adulthood to determine childhood oral health

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and SES predictors of adult caries. Hence, the aim was to assess, using a life course framework, whether SES at the age of 13 years modified the relationship between childhood caries and oral health of young adults aged 30 years.

Materials and Methods

Sampling and Data Collection

The sample comprised children at age 13 years who were all in the School Dental Service (SDS), hence having exposure to equitable access to preventive and treatment services in childhood. At the time of recruitment in 1988–1989 the SDS in South Australia provided free dental care to students under the age of 18 years, and provided general dental care to 71.3% of 13-year-old students [Spencer et al., 1995]. A total of 7,673 children aged around 13 years attending for regular recall examinations were sampled from the SDS of South Australia during 1988–1989. This meant that children included in the study were enrolled with the SDS and attended for a recall examination during the period of recruitment. Parents were approached by mail for consent for their child to participate in the study, with 4,476 parents giving informed consent. Data were collected from parents and children using a mailed self-complete survey, while SDS staff collected data on oral health and dental treatment. Of the original study sample 66% were from metropolitan Adelaide, which had been fluoridated since 1971. In 2005–2006, the contact details of the sample were updated using the electoral roll. Traced study participants residing in metropolitan Adelaide aged around 30 years (n = 1,859) were then surveyed by mailed self-complete questionnaire, with up to four follow-up mailings to non-respondents [Dillman, 1978]. Respondents to the questionnaire were invited to attend an oral epidemiological examination. Trained and calibrated dentists conducted the examinations using mirrors and probes under standardised illumination, according to standardised diagnostic criteria [NIDR, 1987]. Radiographs were not taken. A subset of 11 cases was re-examined to assess reliability. An additional 547 persons of similar age were randomly sampled from the electoral roll in 2005–2006 to serve as a comparison group to the baseline study participants who were followed up. The rationale for the comparison group was to provide an independent population sample to assess the representativeness of the participants followed up in the main study.

Outcome Measures

Dental caries at age 30 years in 2005–2006 was recorded for all teeth present in the mouth, including third molars, during the oral examination. Teeth were categorised as present or missing for caries or other reasons, and surfaces of tooth crowns were categorised as decayed, filled or sound. Five surfaces were coded for premolars and molars, with four surfaces coded for incisors and canines. For analysis, decayed, missing and filled teeth were computed, with a tooth designated as decayed if any coronal surface was decayed, regardless of the status of the other coronal surfaces. If at least one coronal surface was filled, but there were no decayed surfaces, the tooth was designated as filled. The total number of teeth missing due to caries was summed.

Explanatory Variables

The main explanatory variables comprised health card status and caries at age 13 years. Health card status at age 13 was collected through the baseline questionnaire which was completed by parents, with card status referring to whether the family in which the child lived was covered by a government health card (examples include aged pensioners and the unemployed). Health card status has policy relevance in that holders of such cards are recipients of government benefits and programs [Brennan et al., 2000], with eligibility criteria that clearly identify card holders as a disadvantaged group. For this analysis card status was used as an indicator of socio-economic disadvantage at a point in childhood. It is possible to change card status, e.g. if an unemployed parent becomes employed, and also when the child reaches adulthood and is no longer a dependent. Caries at age 13 was collected from SDS records, and was coded into lower (DMFT <3) and higher (DMFT 3+). A threshold for DMFT of 3 was used as a cut-off point as it exceeded the mean of 2.1, enabling sufficient numbers per group for analysis, and facilitating interpretable interaction terms. This cut-off point for DMFT was chosen on a conceptual basis to represent disadvantage through higher than average levels of caries at age 13 compared to those with average or lower levels of caries. The covariates of tooth brushing frequency and sex were collected in the questionnaire at age 30 years. Tooth brushing frequency was coded into the categories of 8 or more times per week (equating to more than once a day) and 0–7 times per week (equating to once a day or less).

Analysis

Response rates were determined, and adjusted for subjects who could not be contacted (i.e. were not residing at the traced address). Bias was examined by comparing baseline characteristics of those who responded in 2005–2006 to those who did not respond, and by comparing the characteristics of those baseline participants who responded in 2005–2006 to the comparison group members who responded, with means and percentages tested using t tests and χ^2 tests. Distributions of variables were examined. Bivariate associations of the outcomes by the explanatory variables were tested using Poisson regression for caries experience, with rate ratios (RR) from multivariate models reported as the adjusted effects. Models were adjusted for tooth brushing and sex, and included interaction terms for card holder status by caries at age 13 years.

Ethics Clearance

In both 1988–1989 and 2005–2006 ethics clearance was obtained from the Human Research Ethics Committee of the University of Adelaide.

Results

Response

In 1988–1989, 4,604 children (60.0%) and 4,476 parents (58.3%) returned questionnaires, with a total of 3,925 students who were examined by the SDS and where both parents and students completed questionnaires. In 2005–2006, 632 baseline study participants responded (43.0%

Table 1. Unadjusted associations with oral health variables at age 30

	Distribution		Decayed teeth		Missing teeth		Filled teeth		DMFT index	
	n	%	mean	SE	mean	SE	mean	SE	mean	SE
DMFT, age 13			**		**		**		**	
Lower, DMFT <3	296	66.2	0.63	0.08	0.18	0.05	2.47	0.18	3.28	0.21
Higher, DMFT 3+	151	33.8	1.06	0.18	0.42	0.15	5.97	0.25	7.44	0.32
Card status, age 13			**		NS		NS		NS	
Card holder	114	26.2	1.11	0.20	0.24	0.07	3.53	0.33	4.88	0.38
No card	321	73.8	0.66	0.08	0.23	0.06	3.70	0.19	4.59	0.23

NS = Not significant. ** $p < 0.01$.

response of those traced and living in Adelaide), with an additional 145 persons from the newly sampled comparison group (33.9% response).

Representativeness: Comparison of Baseline Characteristics

Comparison of baseline characteristics showed that those who responded in 2005–2006 had a higher percentage of females, a higher percentage with male and female parents who had tertiary education, a higher percentage with male parents working, a lower percentage covered by a health care card and a higher percentage from higher household income groups. There were no differences in country of birth, occupation of either parent or employment status of female parents, and no differences in 10 measures of oral health status at age 13 years (oral hygiene score, calculus score, number of deciduous teeth, DAI score and number of permanent teeth that were restored sound, carious, unsatisfactory restorations, needing extraction, extracted due to caries and DMFT).

Representativeness: Similarity to Newly Sampled Comparison Group

Comparison between the baseline participants who responded in 2005–2006 and the similar age comparison group showed that the longitudinal respondents were more likely to be working but were no different in 5 other demographic characteristics (sex, country of birth, education level, income and health card status), and no different in 3 dental behaviour variables (time since last visit, reason for last visit and toothbrushing frequency). They had a higher rate of fillings in the past year but were not different in 4 other service variables (number of visits, examinations, scale and clean services, and extractions), and were not different in 4 measures of caries experience (numbers of decayed, missing and filled teeth, and DMFT).

Reliability of Clinical Measures

Reliability of the oral health measures recorded in 2005–2006 was excellent for missing teeth (intra-class correlation = 1.00), filled teeth (intra-class correlation = 0.86) and DMFT (intra-class correlation = 0.90), and good for decayed teeth (intra-class correlation = 0.62).

Distributions and Unadjusted Associations

Just over a quarter were health card holders (26.2%), with a third (33.8%) in the higher caries group at age 13 (table 1). The distribution of DMFT at age 13 was as follows: 30.7% with DMFT = 0, 18.1% DMFT = 1, 17.5% DMFT = 2, 12.1% DMFT = 3, 10.7% DMFT = 4, 4.5% DMFT = 5, 2.2% DMFT = 6 and 4.2% with DMFT 7+. Higher levels of DMFT at age 13 were associated with higher numbers of decayed, missing and filled teeth and DMFT at age 30 compared to those with lower levels of DMFT at age 13. Card holders at age 13 had significantly more decayed teeth at age 30, but had similar numbers of missing and filled teeth and DMFT as those with no health card.

Adjusted Models

Models adjusted for tooth brushing frequency and sex showed that those with higher DMFT at age 13 had more decayed teeth (RR = 2.0, 1.4–3.0), filled teeth (RR = 2.1, 1.8–2.6) and higher DMFT (RR = 2.1, 1.7–2.5) at age 30 (table 2). Card holders at age 13 had more decayed teeth at age 30 (RR = 2.2, 1.4–3.3), but fewer filled teeth at age 30 (RR = 0.6, 0.5–0.9). Significant interactions were observed for card status by DMFT at age 13 for decayed,

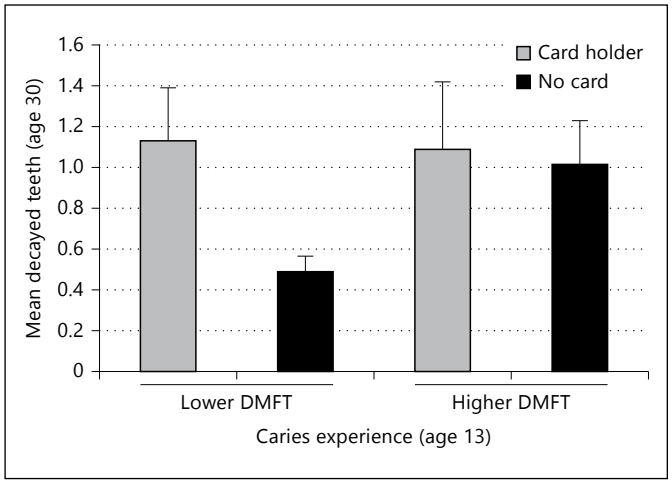

Fig. 1. Mean decayed teeth at age 30 years by card status and caries at age 13 years.

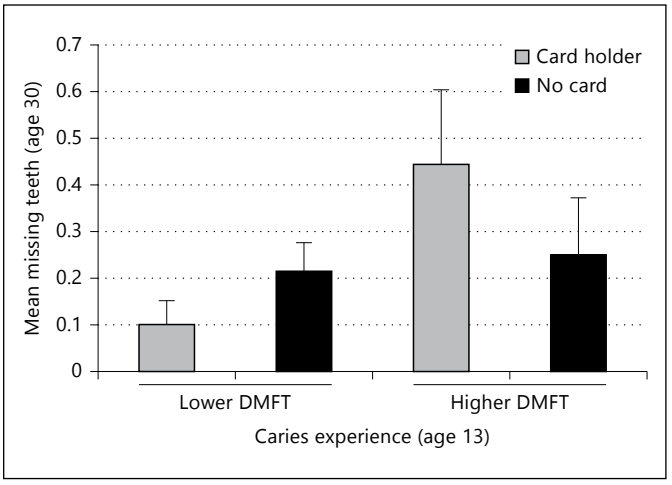

Fig. 2. Mean missing teeth at age 30 years by card status and caries at age 13 years.

Table 2. Adjusted associations with oral health variables at age 30

	Decayed teeth		Missing teeth		Filled teeth		DMFT index	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
DMFT, age 13								
Lower, DMFT <3	ref.		ref.		ref.		ref.	
Higher, DMFT 3+	2.0**	1.4, 3.0	1.2	0.7, 1.9	2.1**	1.8, 2.6	2.1**	1.7, 2.5
Card status, age 13								
Card holder	2.2**	1.4, 3.3	0.5	0.2, 1.05	0.6**	0.5, 0.9	0.9	0.7, 1.1
No card	ref.		ref.		ref.		ref.	
Interaction								
Card status × DMFT	0.5*	0.2, 0.9	3.5*	1.3, 9.5	1.7*	1.1, 2.5	1.3	0.9, 1.8

Estimates are adjusted for sex and tooth brushing frequency at age 30 years. * $p < 0.05$, ** $p < 0.01$, ref. = reference category.

missing and filled teeth at age 30. The interaction for decayed teeth at age 30 showed that while higher DMFT at age 13 was associated with more decayed teeth at age 30 for those with no health card, there were similar numbers of decayed teeth at age 30 for card holders regardless of their DMFT at age 13 (fig. 1). The interaction for missing teeth at age 30 showed that higher DMFT at age 13 was associated with more missing teeth at age 30 for card holders, while there were similar numbers of missing teeth at age 30 for those with no card regardless of their DMFT at age 13 (fig. 2). The interaction for filled teeth showed that even though higher DMFT at age 13 was associated with more fillings at age 30 for both card holders and those with no health cards, this relationship was more pronounced for card holders (fig. 3). There was no significant interaction for DMFT, as the main effects showed similar levels of DMFT for both card holders and those with no card, but higher DMFT at age 30 was associated with higher DMFT at age 13 years.

Discussion

The findings indicated that SES modified the relationship between child oral health and caries at age 30 years, but not overall DMFT. Higher caries level in childhood was associated with more decayed teeth at age 30 for those with no health card, while for card holders de-

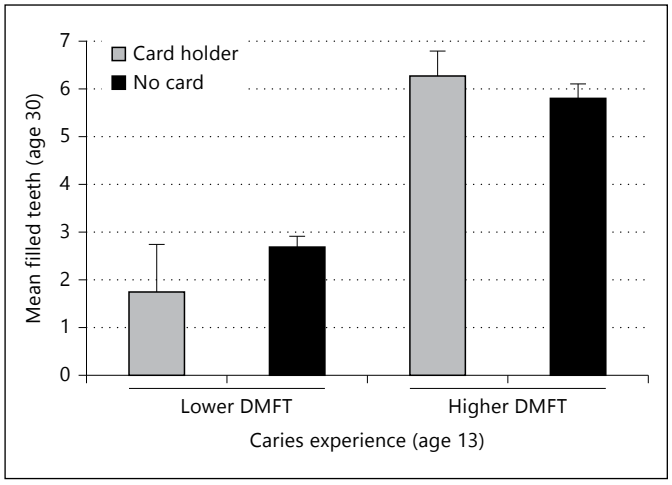

Fig. 3. Mean filled teeth at age 30 years by card status and caries at age 13 years.

cayed teeth did not vary by caries level in childhood. Higher childhood caries was associated with more missing teeth at age 30 for card holders but not for those without a health card. While higher levels of caries in childhood was associated with more fillings at age 30 for both card holders and those with no card, this relationship was more pronounced for card holders. Caries at age 30 was predicted by childhood caries level, but it was neither related to nor modified by card status, suggesting that SES was associated with similar disease experience but different management of disease, resulting in variations in caries outcomes. These findings have significance in relation to life course explanations of oral health, and may be interpreted in terms of health selection and social causation.

There is evidence of SDS coverage having a positive association with oral health, with children receiving public care (although being from less advantaged backgrounds) having more favourable oral health [Gaughwin et al., 1999]. However, for adults the receipt of public care in Australia has been associated with more extractions and less preventive and maintenance care [Brennan et al., 2008]. Dental service provision in private general practice has been associated with a range of dental provider characteristics [Brennan and Spencer, 2005] as well as patient and practice characteristics [Brennan and Spencer, 2002]. Further, rates of relief of pain and extractions have been associated with lower income and lower education [Roberts-Thomson et al., 2008]. Variations in rates of dental services have been linked to issues of appropriateness of care [Bader and Shugars, 1995].

These findings add to the evidence base on life course explanations of oral health, particularly in relation to the young adult life stage. Young adulthood represents a life stage of transition and growing independence [Australian Bureau of Statistics, 2005]. Previous evidence on young adults from Australia has shown that oral health-related quality of life was impacted by negative life events [Brennan and Spencer, 2009]. The present findings generally show either worse oral health for those who were card holders at age 13 or for those who jointly had higher childhood caries and were also card holders at age 13 years. Previous reports have demonstrated social inequality in oral health by health card status such as higher numbers of missing teeth among middle-aged Australian card holders [Brennan et al., 2007], and while card holders have shown population trends towards greater tooth retention over time, those attending for public care have greater numbers of decayed teeth [Brennan and Spencer, 2004].

Life course data from New Zealand has shown an oral health gradient among young adults by childhood SES [Thomson et al., 2004], indicating support for cumulative adverse exposures contributing to oral health problems over the life course [Nicolau et al., 2007]. Reports from New Zealand and Brazil have highlighted SES mobility in relation to oral health of young adults [Peres et al., 2011a]. Data from Finland and Brazil have shown support for cumulative risk, social mobility and critical period life course models in relation to oral health of young adults [Bernabe et al., 2011; Peres et al., 2011b]. These have shown that SES in the form of education, income and occupation can influence oral health of young adults over the life course through mobility effects, cumulative effects and at sensitive periods. Other explanations discussed below include the effects of health selection and social causation.

SES gradients in health may be taken as indications that SES affects health (the social causation hypothesis), while childhood health has been suggested as a link to adult SES and SES gradients in adult health (the health selection hypothesis) [Elvaino et al., 2011]. In the health selection hypothesis childhood health is linked via career prospects to adult SES and health, while in the social causation hypothesis SES affects health through career, as well as access to goods and services. While no explicit link is made here between the intermediate step involving career paths, it is possible to examine the links between childhood health and childhood SES with oral health in adulthood in view of potential health selection and social causation effects.

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If childhood caries is taken as a measure of biological risk or health status then the higher levels at age 30 years of decayed teeth for those with no card, missing teeth for card holders, and filled teeth regardless of card status may be taken as potential support for a health selection effect whereby earlier health status predicts later health status. However, the presence of interactions provides support for social causation effects where decay is higher for card holders regardless of childhood caries level, missing teeth are lower for those with no card regardless of childhood caries level, and while filled teeth are higher for those with higher childhood caries the effect is greater for card holders.

While this shows partial support for both health selection and social causation effects the overall effect is that those who were card holders at age 13 tend to be worse off in terms of their oral health at age 30, and the effect is not removed when controlled by inclusion of differences in childhood oral health levels in the analysis. This may be interpreted as greater support for social causation as a mechanism for oral health inequalities.

The baseline respondents in 1988–1989 could be considered demographically representative as they closely approximated the population profile [Allister et al., 1996]. Comparison of baseline characteristics from 1988–1989 for the traced baseline study members who responded at follow-up in 2005–2006 against the other study members showed loss to follow-up from lower SES groups, but this did not result in bias in their baseline oral health status. However, differences in baseline SES could diverge into differences in patterns of dental care as the study participants moved from childhood to adulthood and impact on oral health outcomes over time [Crocombe et al., 2011]. Comparison of the respondents from both 1988–1989 and 2005–2006 with a similarly aged comparison group from 2005–2006 showed the longitudinal respondents were more likely to be working, but with no difference in caries. The low response rate and loss to follow-up from lower socio-economic groups is a limitation of the study that could potentially underestimate the observed socio-economic disparities.

In conclusion, SES modified the relationship between child oral health and caries at age 30 years. Those who were card holders at age 13 were worse off in terms of their oral health outcomes at age 30 when controlling for differences in childhood caries, supporting social causation explanations for oral health inequalities.

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Disclosure Statement

The authors have no conflicts of interest to declare.

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